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NOTES ON LARKSPUR ERADICATION ON STOCK RANGES.

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The losses of cattle from larkspur upon the range continue to be very large, but are being reduced gradually as stockmen use more and more the measures which have been found effective and are given in detail in the publications of the United States Department of Agriculture.

There are three ways by which the losses may be reduced: (1) By the use of the medicinal remedy; (2) by herding the animals away from the plants during the time when they are most poisonous; (3) by destroying the plant.

As indicated in previous publications, the main reliance must be upon the second and third methods, inasmuch as many cases of poisoning occur when the remedy can not be applied because the stockman is not on hand at the right time.

In the attempts to eradicate the plant many areas of larkspur have been grubbed out. That this work is an economic success there is no question.¹ Where complete eradication is an impossibility, it happens frequently that enough of the plant may be destroyed to reduce the losses, if not eliminate them completely; for it must be remembered that a considerable quantity of the plant must be eaten, and in a short time, to produce serious illness. Even if the work had to be repeated frequently it would still be profitable, for the value of a single steer will pay for a large amount of work, and in many restricted areas the annual losses of cattle are quite large.

It has appeared, however, that in some localities the work of digging up the larkspur has not been so successful in eliminating the plant as could be desired, and an examination of the areas where digging has been tried has led to the belief that the cutting of the roots may have left some buds. In Bulletin 365, United States Department of Agriculture, it is stated that tall larkspur can be killed by cutting the root 2 or 3 inches from the surface. This statement, however, was based on preliminary observations.

Under the circumstances it seemed desirable to make some definite experiments to determine more exactly what was necessary to insure that the plants were actually killed. The results of these

¹ See Farmers' Bulletin 826, "Eradicating Tall Larkspur on Cattle Ranges in the National Forests"

experiments and observations, while not as complete as may be desired, inasmuch as only a few species have been under observation, nevertheless are sufficiently definite to be of decidedly practical importance, and it is thought that they should be published in order to assist those who are attempting to grub out the plants.

EXPERIMENTS IN CUTTING ROOTS.

The roots of the tall larkspur are tough and fibrous, of varying lengths up to a foot or more, and live for an undetermined number of years, the older part of the root dying off. The annual shoots originate on the upper part of the root from buds, some of which are beneath the surface of the ground.

One question for solution was whether, when the upper part of the root was cut off below existing buds, adventitious buds might not be formed on the remaining portion of the root, so that there would be danger of further growth if any part of the root remained.

If it were found that adventitious buds were not liable to be formed, it was necessary to determine how far beneath the surface of the ground it was necessary to cut the root in order to stop further growth.

To settle these questions, definite experimental evidence was sought, with the following results:

DELPHINIUM BARBEYI.

On an area in the Fishlake National Forest, Utah, on August 13, 1916, 28 plants of *Delphinium barbeyi* were selected and cut off at various depths. These roots were marked and examined again on August 22, 1917. The following table gives the results:

Results of experiments in cutting roots of Delphinium barbeyi.

Plant No.	Distance of cut below surface of ground.	Distance of cut below buds.	Result.
1	15 cm. (6 in.)	Just below the buds	Root dead.
2	10 cm. (4 in.)	do.	1 living shoot.
3	10 cm. (4 in.)	Junction of stems and roots	2 shoots; 5 buds.
4	15 cm. (6 in.)	10 cm. (4 in.)	No shoots; living tissue in roots
5	12 cm. (5 in.)	3 cm. (1 in.)	Do.
6	12 cm. (5 in.)	9 cm. (3½ in.)	Do.
7	10 cm. (4 in.)	Just below the buds	1 shoot.
8	5 cm. (2 in.)	do.	5 shoots.
9		12 cm. (5 in.)	No shoots; living tissue in roots
10		5 cm. (2 in.)	Do.
11		4 cm. (1½ in.)	Roots disappeared.
12	15 cm. (6 in.)	Just below the buds	Do.
13	15 cm. (6 in.)	6 cm. (2 in.)	Do.
14	8 cm. (3 in.)	Just below the buds	1 shoot.
15	10.5 cm. (4.2 in.)	4 cm. (1½ in.)	No shoots; living tissue in roots.
16	10 cm. (4 in.)	Just below the buds	Do.
17	15 cm. (6 in.)	6 cm. (2.3 in.)	Do.
18	10.5 cm. (4.2 in.)	Just below the buds	Roots disappeared.
19	5 cm. (2 in.)	do.	3 shoots.
20	10.5 cm. (4.2 in.)	2 cm. (¾ in.)	No shoots; living tissue in roots.
21	5 cm. (2 in.)	Just below the buds	Do.
22	8 cm. (3 in.)	3 cm. (1 in.)	Roots disappeared.
23	10.5 cm. (4.2 in.)	5 cm. (2 in.)	No shoots; living tissue in roots.
24		Just below the buds	3 shoots.
25	10.5 cm. (4.2 in.)	6 cm. (2.3 in.)	No shoots; living tissue in roots.
26	4 cm. (1½ in.)	4 cm. (1½ in.)	3 shoots.
27	2.5 cm. (1 in.)	Just below the buds	1 shoot.
28		16 cm. (6.4 in.)	No shoots; living tissue in roots.

Twelve of these plants were cut off just below the buds. Of these 12, 4 had no shoots. Of the 4, in 2 cases the roots had disappeared, in 1 the root was dead, and in the remaining 1, although there were no shoots there was still living tissue in the root.

One plant was cut off at the junction of the stems with the roots without regard to buds, and in this case there were 2 shoots and 5 buds.

The other 15 plants were cut off at distances from the buds varying from 2 centimeters ($\frac{3}{4}$ inch) to 15 centimeters (6 inches). Of these there was growth from only one, which was cut at 4 centimeters ($1\frac{1}{2}$ inches).

The general inference from these experiments is that a cut below the buds will stop further growth. The fact that growth appeared in 7 plants cut just below the buds is probably explained by supposing that buds were overlooked rather than that the growth was from adventitious buds. If adventitious buds grow from the roots it seems probable that they would have been found on some of the plants which were cut at from 2 to 16 centimeters ($\frac{3}{4}$ to 6.4 inches) from the 1916 buds.

It seems clear, too, that if, to avoid the result of defective observation, the cut is made from 4 to 5 centimeters ($1\frac{1}{2}$ to 2 inches) below observed buds, further growth will certainly be prevented.

These plants were examined July 1, 1917. At that time Nos. 2, 7, 14, 19, 20, and 27 had no shoots, although on August 22 all had shoots. This would indicate that some of the shoots start rather late in the season, and that the most effective time for grubbing plants is at the period of blossoming, when all the shoots of the year have appeared.

It should be noted that 13 of the experimental plants still had living tissues in their roots, although no shoots had sprung from them. These plants are still under observation, but it is not deemed probable that there will be any further growth.

In 23 cases notes were kept in regard to the depth of the cut below the surface of the ground. These notes have a considerable possible margin of error, inasmuch as it is difficult to measure the distance exactly. Of the 7 plants cut at 8 centimeters (3 inches) or less, 4 produced shoots. Of 4 cut at 10 centimeters (4 inches), 3 produced shoots. From 12 cut at 10.5 centimeters (4.2 inches) or more, there was no growth. The inference for practical purposes is that the cut should be 12 centimeters (5 inches) or more below the surface.

Mr. W. W. Eggleston, representing the Bureau of Plant Industry, who cooperated in this work, dug up and examined 15 plants of this same species (*Delphinium barbeyi*) on the Gunnison National Forest in Colorado, and found that the buds were from 3 to 5 inches below the surface.

The general inference from the observations on *D. barbeyi* in these two localities is that laborers who dig up this species of larkspur should be instructed to cut the roots at least 6 to 8 inches below the surface to be sure of effective results.

DELPHINIUM CUCULLATUM.

Delphinium cucullatum is the common species of tall larkspur in Montana and is found in some of the adjoining States.

On September 7, 1917, 27 specimens of this plant were collected by W. W. Eggleston in Cottonwood Canyon near Fairview, Utah. These were measured with reference to the depths of the buds below the surface, with the following results:

Results of examination of Delphinium cucullatum to determine depth of buds below surface.

Depth of buds below surface.	Number of plants.
4 cm. (1.5 in.).....	2
5 cm. (2 in.).....	5
6.35 cm. (2.5 in.).....	4
3 cm. (3 in.).....	9
10.5 cm. (4 in.).....	2
11.43 cm. (4.5 in.).....	1
12 cm. (5 in.).....	2
13.99 cm. (5.5 in.).....	1
15 cm. (6 in.).....	1

It is seen that the greatest distance from the surface at which buds were found was 6 inches, and that in 23 of the 27 plants no buds were found below 4½ inches. It is evident that to be sure of killing *D. cucullatum* by grubbing, the cut should be 8 inches below the surface of the ground.

DELPHINIUM GERANIIFOLIUM

A cursory examination was made of a few plants of *Delphinium geraniifolium* near Flagstaff, Ariz. It was found that in order to be reasonably certain of cutting below the buds this species should be cut at least 6 inches below the surface.

SOME SPECIES MORE EASILY DESTROYED.

It is known that some species of high larkspurs have a much more shallow root system than the three which have been discussed. This is true of some of the high larkspurs occurring in Idaho in which the root is so short that in many cases it is not difficult to pull it up, especially when the ground is wet. Where this can be done it is certain to destroy the plant and its eradication can therefore be accomplished with less labor than is necessary where all the plants have to be grubbed out.

SUMMARY.

1. Attempted eradication of larkspur from stock ranges in the West in some cases has not been as satisfactory in eradicating the plants as it might have been, because the roots were not cut at the depth necessary to stop further growth.

2. Experimental cutting of *Delphinium barbeyi* followed by observation of the effect a year later shows that to insure results the roots should be cut at least from 6 to 8 inches below the surface.

3. Observations upon two other species, *D. cucullatum* and *D. geraniifolium*, show that in them also the cutting should be at least from 6 to 8 inches below the surface.

4. Certain of the high larkspurs have shallow roots, so that many of the plants can be pulled up.

5. In giving directions to laborers who are engaged to grub out tall larkspur it is best, in the case of all larkspurs, to require from 6 to 8 inches of the root to be dug up.

It should be noted in this connection that the larkspur which is dug up should not be left in piles where cattle can get at it, for the dried larkspur is toxic and sometimes cattle show an especial fondness for it. There have been cases of rather heavy losses under such circumstances.

6. The best time to dig the larkspur is at about the period of blossoming, for earlier all the shoots of the year will not have developed.

Of course in subsequent years seedlings will have to be dealt with, for the plants grow from both roots and seeds.

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The Cause of the "Spewing Sickness" of Sheep. (Leaflet A. 9.)
Cicuta (Water Hemlock) as a Poisonous Plant. (Leaflet A. 15.)
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